## REMARKS

Claims 21 to 23, 25 to 26, 28 to 32 and 34 to 40 are pending in the present application. Applicants respectfully submit that the pending claims are patentable for the following reasons.

### I. Rejection of Claims 21 to 23, 25, 26, 29 to 32, 37 and 40

Claims 21 to 23, 25, 26, 29 to 32, 37 and 40 were rejected under 35 U.S.C. §103(a) as allegedly being unpatentable over United States Patent No. 6,051,503 ("Bhardwaj et al.") in view of United States Patent No. 6,277,173 ("Sadakata et al."). It is respectfully submitted that the combination of Bhardwaj et al. and Sadakata et al. does not render these claims unpatentable for the following reasons.

Claim 21 relates to a method for anisotropically etching structures into a substrate positioned in an etching chamber, comprising: providing an etching mask on a silicon substrate positioned in the etching chamber; and providing the etching chamber at least intermittently with an etching gas and at least intermittently with a passivation gas, wherein the passivation gas is supplied to the etching chamber in cycles each having a time period between 0.05 second and 1 second; wherein the etching gas and the passivation gas are used alternately during separate etching steps and passivation steps that are controlled independently of one another, the passivation gas being supplied to the etching chamber substantially only during the passivation steps, and the etching gas being supplied to the etching chamber substantially only during the etching steps; and the duration of the passivation steps is set to be shorter than the duration of the etching steps by a factor of 10 to 30.

***Neither Bhardwaj et al., nor Sadakata et al. disclose or suggest that a duration of passivation steps is set to be shorter than a duration of etching steps by a factor of 10 to 30***, i.e., by at least one order of magnitude. The passage cited by the Office Action, i.e., column 10, lines 19 to 22 of Bhardwaj et al., merely states that the etching and deposition steps should be less than 7.5 seconds, and preferably less than 5 seconds. This constitutes a statement about the absolute maximum duration of the two

process steps, but not at all about the relative ratio of the two etching and passivating durations with respect to each other. In addition, the Office Action states, on page 4, that the duration of the passivation and etching steps is dependent on several experimental variables, which one skilled in the art would be motivated to optimize through routine experimentation in order to, e.g., reduce surface roughness. ***However, the claimed factor of 10 to 30 means that the passivation steps of Bhardwaj et al. would have to be significantly less than one second, which is not readily possible using conventional mass flow regulators and valves, due to their mechanical inertia. Thus, one skilled in the art would not be capable of setting the ratio of etching step duration to passivation step duration to between 10 and 30, given the apparatus of Bhardwaj***. Moreover, Sadakata et al. do not cure the deficiencies of Bhardwaj et al. with respect to the above-mentioned feature.

The described factor of 10 to 30 is an essential feature of the method according to claim 21, since as a result, etching is performed with such short interruptions that there is practically one uninterrupted etching process, a particularly high etching rate may be achieved and anisotropic profiles, i.e., profiles having vertical lateral walls are etched, and no or only minimal lateral wall roughnesses entirely negligible in practice occur. In addition, the factor of 10 to 30 may be achieved only by the fact that with the aid of the device described in the Specification, made up of a buffer tank and switchover valve in the gas supply, a transition may be made to very short passivating cycle periods of below 1 sec, e.g. 50 ms to below 1 sec. This realization that very short passivating cycle periods advantageously allow for a very high ratio of etching to passivating cycles represents an inventive feature, which was not known in the related art prior to the present Application. The prior art simply does not allow one to set such a high ratio of etching duration to passivation duration in an anisotropic (i.e., vertical profile) etching process.

In addition, in Figures 19(a) and 19(b), an etching phase of 13 or 12 sec and a passivating phase of 7 sec is described, i.e. the passivating phase is shorter than the etching phase by a factor of not even 2. Thus the durations of the passivating and etching phases are in the same order of magnitude. According to claim 21, given an etching phase duration of 13 sec, the

passivating phase duration should last at most 1.3 sec (which is 10 times less than the etching phase duration). When setting a passivating phase duration of 1.3 sec, however, it would not be reconcilable with the requirement of anisotropic etching to set such a high ratio of etching to passivating cycle periods in the process. Rather, such a process would etch isotropically, i.e. produce no vertical profiles. Given the indicated ratio of cycle periods, the requirement of etching vertical profiles can only be met if the passivating phase duration is substantially below 1 sec. There is no prior art that discloses or suggest such a passivation time.

***Furthermore, neither Bhardwaj et al., nor Sadakata et al. disclose or suggest that passivation gas is supplied to an etching chamber in cycles each having a time period between 0.05 second and 1 second***. As mentioned above, in column 10, lines 19 to 22, Bhardwaj et al. merely indicate that the deposition steps should be less than 7.5 seconds, and preferably less than 5 seconds. In addition, in column 6, lines 50 to 53, Bhardwaj et al. indicate that deposition steps are typically 2 to 15 seconds and preferably 4 to 6 seconds. Furthermore, as indicated in the concrete examples shown in Figs. 19(a) and 19(b), the deposition steps are set to 7 seconds. Moreover, one skilled in the art would not be motivated to set, or capable of setting, the deposition step duration to between 0.05 sec to 1 sec for reasons given in the preceding paragraph. Finally, Sadakata et al. do not cure the deficiencies of Bhardwaj et al. with respect to the above-mentioned feature.

Accordingly, it is respectfully submitted that the combination of Bhardwaj et al. and Sadakata et al. does not render claim 21 unpatentable for at least these reasons.

As for claims 22, 23, 25, 26, 28 and 29, which ultimately depend from claim 21 and therefore include all of the features recited in claim 21, it is respectfully submitted that the combination of Bhardwaj et al. and Sadakata et al. does not render these dependent claims unpatentable for at least the same reasons more fully set forth above in support of the patentability of claim 21.

As for claims 25 and 29, it is respectfully submitted that the combination of Bhardwaj et al. and Sadakata et al. does not render these claims unpatentable for the following additional reasons.

As regards claim 25, neither Bhardwaj et al., nor Sadakata et al. disclose or suggest that a passivation gas includes at least one of $C_4F_8$, $C_3F_6$, $C_4F_6$, $C_5F_8$, and $C_2H_2F_2$. The gases listed on page 5, lines 1 to 2 of the Office Action do not correspond to any of the gases claimed in claim 25. In addition, Bhardwaj et al. describe, in column 2, lines 18 to 19, a ***passivation layer*** of the form $CF_x$, not a ***passivation gas*** of the form $CF_x$. Furthermore, in column 2, lines 49 to 52, none of the gases described by Bhardwaj et al. as possible components in a deposition gas include $C_4F_8$, $C_3F_6$, $C_4F_6$, $C_5F_8$, or $C_2H_2F_2$, as provided in claim 25.

As regards claim 29, neither Bhardwaj et al., nor Sadakata et al. disclose or suggest that an amount of the passivation gas used during each of individual passivation steps is reduced one of continuously and in steps as etching progresses. Contrary to the contentions appearing at page 3, lines 10 to 12 of the Office Action, Bhardwaj et al. merely state, in column 2, lines 29 to 30, that the ***chamber pressure may be reduced*** and/or ***the flow rate increased*** during deposition. Reducing the chamber pressure does not necessarily imply reducing an amount of passivation gas, and increasing the flow rate certainly does not imply reducing an amount of passivation gas. At any rate, Bhardwaj et al. make no mention whatsoever of reducing an amount of passivation gas continuously or in steps.

Accordingly, it is respectfully submitted that the combination of Bhardwaj et al. and Sadakata et al. does not render claims 25 and 29 unpatentable for these additional reasons.

Claim 30 relates to a plasma system for anisotropically etching structures into a substrate, comprising: an etching chamber for accommodating the substrate, wherein the substrate is positioned on a substrate electrode located within the etching chamber; a plasma source for producing a plasma acting on the substrate; and-a supply arrangement for at least intermittently supplying an etching gas and at least intermittently supplying a passivation gas to the etching chamber; a passivation gas line provided upstream from the etching chamber; a buffer tank located along the passivation gas line upstream from the etching chamber; and a passivation gas valve located downstream from the buffer tank and upstream from the etching chamber.

***First of all, neither Bhardwaj et al., nor Sadakata et al. disclose or suggest a buffer tank located along the passivation gas line upstream from the etching chamber and a passivation gas valve located downstream from the buffer tank and upstream from the etching chamber***. Sadakata et al. do describe a buffer tank and associated valves. However, the buffer tank of Sadakata et al. is not located along a passivation gas line, but along a line dedicated to starting gas and gases recycled after passing through a detoxification unit in an exhaust line of a manufacturing apparatus. Sadakata et al. do not mention any passivating gas or passivating gas line. In addition, as indicated in column 4, lines 51 to 55 of Sadakata et al., the gas in the buffer tank is provided as an inert gas.

***In addition, the motivation provided from page 3, line 19 to page 4, line 2 of the Office action, for employing the buffer tank and gas valves of Sadakata et al. in the reactor of Bhardwaj et al. - namely, to regulate the concentration of gas into a process chamber during etching - is invalid.*** In Sadakata et al., the buffer tank does help to adjust the concentration of gas entering a process chamber (see column 6, lines 47 to 54) with the aim of recycling unused process gas quantities. For recycling tasks, the temporary storage of unused quantities in tanks is known. However, the buffer tank is needed in Sadakata et al. because the gas is supplied by at least one source, in this case an exhaust line of a detoxification unit, which does not necessarily provide the gas at a known or constant concentration. Therefore, a buffer tank is needed to adjust this concentration. ***However, in the reactor of Bhardwaj et al., there is no indication that any source of process gases is providing these gases at a concentration that is unknown or fluctuating. Thus, although, as alleged on page 10, lines 18 to 19, one skilled in the art should be able to position the buffer tank (of Sadakata et al.) upstream from the etching chamber (of Bhardwaj et al.), there is no valid reason to do so, as the concentration of the passivation gases in Bhardwaj et al. is not in need of adjustment***. Furthermore, there is no connection at all between recycling of gas quantities by temporarily storing them in buffer tanks and using a buffer tank to supply a gas to a plasma process in a pulsed, ultra-fast manner. Therefore, it is respectfully submitted that the regulation of the concentration of gas into a

process chamber is not a proper motivation for combining the teachings of Bhardwaj et al. and Sadakata et al.

In contrast to Sadakata et al., the buffer tank (24) of the present Application is present in a passivation gas line, in order to rapidly discharge passivation gas into the etching chamber (12) in a manner not readily possible using conventional mass flow controllers and valves, due to mechanical inertia. The buffer tank (24) allows for very brief passivation steps of 0.05 seconds to 1 second, so that a high ratio of etching duration to passivation duration of 10 to 30 may be achieved. In addition, Since neither Bhardwaj nor Sadakata even mention the idea of greatly reducing the passivating gas phase duration (below 1 sec), one skilled in the art is not even motivated to determine how a short passivating gas phase duration of at most 1 sec could be achieved technically. However, even if he were motivated to do so, the disclosure of Sadakata et al. does not aid him in his pursuit, since, from Sadakata et al., he does not learn that sudden evacuation of a buffer tank would be a solution for attaining a low passivation duration. Moreover, from the above, he would not be able to draw the knowledge that this brief supply of the passivating gas would allow him to extend the etching cycle period to 10 to 30 times the value of the passivating cycle period and in so doing obtain an anisotropic etching process, which produces vertical profiles having minimal lateral wall roughnesses that are negligible in practice.

Accordingly, it is respectfully submitted that the combination of Bhardwaj et al. and Sadakata et al. does not render claim 30 unpatentable for at least these reasons.

As for claims 31, 32, 37 and 40, which ultimately depend from claim 30 and therefore include all of the features of claim 30, it is respectfully submitted that the combination of Bhardwaj et al. and Sadakata et al. does not render these dependent claims unpatentable for at least the reasons set forth above in support of the patentability of claim 30.

In view of all of the foregoing, withdrawal of this rejection is respectfully requested.

## II. Rejection of Claim 28

Claim 28 was rejected under 35 U.S.C. §103(a) as allegedly being unpatentable over Bhardwaj et al. in view of Sadakata et al. and U.S. Patent Application Publication No. 2003/0059720 ("Hwang et al."). It is respectfully submitted that the combination of Bhardwaj et al., Sadakata et al. and Hwang et al. does not render this claim unpatentable for at least the following reasons.

Claim 28 ultimately depends from claim 21 and therefore includes all of the features recited in claim 21. As set forth above, neither Bhardwaj et al. nor Sadakata et al. disclose or suggest all of the features of claim 21. In addition, Hwang et al. do not disclose or suggest all of the features of claim 21 not disclosed or suggested by Bhardwaj et al. and Sadakata et al. Therefore, it is respectfully submitted that the combination of Bhardwaj et al., Sadakata et al. and Hwang et al. does not render this dependent claim unpatentable for at least these reasons.

In view of all of the above, withdrawal of this rejection is respectfully requested.

## III. Rejection of Claims 34 to 36

Claims 34 to 36 were rejected under 35 U.S.C. §103(a) as allegedly being unpatentable over Bhardwaj et al. in view of Sadakata et al. and United States Patent No. 6,846,745 ("Papasouliotis et al."). It is respectfully submitted that the combination of Bhardwaj et al., Sadakata et al. and Papasouliotis et al. does not render these claims unpatentable for the following reasons.

Claims 34 to 36 ultimately depend from claim 30 and therefore include all of the features recited in claim 30. As set forth above, neither Bhardwaj et al., nor Sadakata et al. disclose or suggest all of the features of claim 30. In addition, Papasouliotis et al. do not disclose or suggest all of the features of claim 30 not disclosed or suggested by Bhardwaj et al. and Sadakata et al. Therefore, it is respectfully submitted that the combination of Bhardwaj et al., Sadakata et al. and Papasouliotis et al. does not render these dependent claims unpatentable for at least these reasons.

In view of all of the above, withdrawal of this rejection is respectfully requested.

## IV. Rejection of Claims 38 and 39

Claims 38 and 39 were rejected under 35 U.S.C. §103(a) as allegedly being unpatentable over Bhardwaj et al. in view of Sadakata et al. and United States Patent No. 5,683,548 ("Hartig et al."). It is respectfully submitted that the combination of Bhardwaj et al., Sadakata et al. and Hartig et al. does not render these claims unpatentable for the following reasons.

Claims 38 and 39 ultimately depend from claim 30 and therefore include all of the features recited in claim 30. In addition, Hartig et al. do not disclose or suggest all of the features of claim 30 not disclosed or suggested by Bhardwaj et al. and Sadakata et al. Therefore, it is respectfully submitted that the combination of Bhardwaj et al., Sadakata et al. and Hartig et al. does not render claims 38 and 39 unpatentable for at least these reasons and the reasons more fully set forth above in support of the patentability of claim 30.

As regards claim 38, it is respectfully submitted that the combination of Bhardwaj et al., Sadakata et al. and Hartig et al. does not render this claim unpatentable for at least the following additional reasons. Neither Bhardwaj et al., nor Sadakata et al., nor Hartig et al. disclose or suggest that a power per area of more than 5 watts/$cm^2$ is provided inside the etching chamber in one of the region near the plasma source and at a location of the substrate. This value of power per unit area is advantageous in that it renders the plasma particularly tolerant to process parameter fluctuations. It is, therefore, respectfully submitted that the combination of Bhardwaj et al., Sadakata et al. and Hartig et al. does not render this claim unpatentable for these additional reasons.

As regards claim 39, it is respectfully submitted that the combination of Bhardwaj et al., Sadakata et al. and Hartig et al. does not render this claim unpatentable for at least the following additional reasons. Neither Bhardwaj et al., nor Sadakata et al., nor Hartig et al. disclose or suggest at least two coils externally enclosing an etching chamber and positioned one above the other, the two coils having current flows in opposite directions, wherein the at least two coils are provided between a plasma source and a substrate. Hartig et al. describe an inductively coupled plasma reactor that includes a plasma source (16) having a plurality of channels (38, 44) into which gases are supplied.

Each channel is surrounded by an independently powered RF coil (54, 56), which is powered by RF power supply system (18). ***However, the coils (54, 56) are part of the plasma source (16) and generate the plasma themselves, and are not provided between the plasma source (16) and the substrate (28) as provided by claim 30. In addition, Hartig et al. make no mention whatsoever of the direction of current flow in coils (54, 56)***.

In view of all of the foregoing, withdrawal of this rejection is respectfully requested.

## V. Conclusion

In view of the foregoing, it is respectfully submitted that all pending claims of the present application are now in condition for allowance. Prompt reconsideration and allowance of the present application are therefore earnestly solicited.

Respectfully submitted,

KENYON & KENYON LLP

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Gerard A. Messina
Reg. No. 35,952
One Broadway.
New York, NY 10004
(212) 425-7200 (telephone)

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